User's Manual

DNLAEM
Version 2.0
Day Night Average Sound Level
Area Equivalent Method

TESTCASE <<<Title

	Day	Night
Total LTOs:	0	0

DNL 65dB
Contour area: NA sq. mi.

No.	Aircraft Type	LTO Cycles Day	LTO Cycles Night
1.	0	0	0
2.	0	0	0
3.	0	0	0
4.	0	0	0
5.	0	0	0

Hit "F6" to switch windows.

Scroll through this window to view aircraft types.

Using the arrow keys, enter selected aircraft types and number of operations into left window. Press <ENTER>when done.

=================

Aircraft Type	Aircraft Description	Aircraft ID
747100	B747-100/JT9BD	1
747200	B747/200/JT9DFL	2
74710Q	B747-100QN/JT9DFL	3
747SP	B747SP/JT9DFL	4
74720	B747-200B/JT9D-7Q	5
DC820	DC-8-20/JT4A	6
707	B707-120/JT3C	7

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NOTICE

9. Performing Organization Name and Address

Federal Aviation Administration
Office of Environment and Energy, AEE-110
800 Independence Ave., S. W.
Washington, DC 20591

10. Work Unit No. (TRAIS)

11. Contract or Grant No.

12. Sponsoring Agency Name and Address

13. Type of Report and Period Covered

User's Manual

14. Sponsoring Agency Code

FAA/AEE

15. Supplementary Notes

16. Abstract

This document contains instructions to execute the **Area Equivalent Method (AEM)**. The AEM requires an IBM® Personal Computer (or compatible) or a calculator.

The AEM is a mathematical procedure that provides an estimate Day Night Average Sound Level (DNL) noise contour area of a specific airport given the types of aircraft and the number of operations for each aircraft.

The AEM has both Novice and Expert mode main menus to assist the user to run AEM more easily and efficiently. This document is the third in a series of reports on the AEM. The first report was titled "Area Equivalent Method on VISICALC® " (Report No. FAA-EE-84-8). The second report was titled "Area Equivalent Method on LOTUS 1-2-3™ " (Report No. FAA-EE-84-12).

17. Key Words

Airport noise, Computer model, Environmental Impact Statement, Day Night Average Sound Level

18. Distribution Statement

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Form DOT F 1700.7 (8-72) Reproduction of completed page authorized and pencil and paper (Reference 1). The AEM described within this report draws upon the techniques developed by J. Watson Noah, Inc. with updated parameters to calculate Day Night Average Sound Level (DNL) contour.

size of the land mass enclosed within a level of noise as produced by a given set of aircraft operations.

The noise contour metric is the Day Night Average Sound Level (DNL) which provides a single quantitative rating of a noise level over a 24-hour period. This rating involves a 10 decibel penalty to aircraft operations during the nighttime (between 10pm and 7 am) to account for the increased annoyance in the community.

The AEM produces contour areas (in square miles) for the DNL 65dB noise level. The AEM is used to develop insights into the potential increase or decrease of noise resulting from a change in aircraft operations. The AEM is a useful screening tool in airport planning and development.

The following text will provide a more detailed explanation of the AEM as well as instructions for its use on the IBM Personal Computer, or compatible. Instructions on the AEM calculator method are also included.

Environment Impacts," an assessment must be made to determine the noise impact of a proposed airport action. This assessment compares the present noise impact on the environment with that of the proposed change. If the noise impact is significant then the FAA requires an Environmental Impact Statement (EIS). If the increase of noise impact on the community is not significant then the FAA prepares a Finding of No Significant Impact (FONSI), which briefly outlines the specifications of the change in airport operations for that particular airport.

An Environmental Impact Statement is a long and involved process which requires use of an airport noise computer model such as the Integrated Noise Model (INM). The INM is a complex and detailed procedure which determines the DNL noise contour area for a specific mix of aircraft, and plots the contour lines relative to runway configuration (Reference 2). The INM is a useful procedure for airport planners, airport operators and local governments in assessing the noise impact to the community around an airport. The INM offers the capability to analyze several operational controls beyond simply changing aircraft mix. The INM is the most appropriate tool for EIS, Part 150 and other federally funded airport environmental studies.

The old Civil Aeronautics Board (CAB) developed the Noise Screening Methodology to decide whether the noise impact due to a change is significant. CAB promulgated this noise screening procedure in 14 CFR 312, Appendix I. It was commonly called the "CAB Procedure." CAB established a decision criterion of 17% increase in cumulative noise contour area. A 17% increase in cumulative noise contour area translates into a one decibel increase in the airport noise. If the percentage difference due to the change is less than 17%, no further study is necessary. The Area Equivalent Method (AEM) is an outgrowth of the CAB Procedure. The FAA applies the same decision criterion to AEM as the CAB did with the Noise Screening Methodology.

The AEM is a screening procedure used to simplify the assessment step in determining the need for an EIS. The purpose of the AEM is to show change in airport DNL noise contour area relative to a change in aircraft mix and number of operations. AEM determines the DNL noise contour area in square miles for a mix and number of aircraft types. The basis of AEM is the equation which determines the DNL noise contour area as a function of the number of daily operations. AEM applies parameters derived from INM output to generate a contour area for each obtained without the use of sophisticated and expensive computer modeling. Many studies, particularly those dealing with national impacts, have used variations of the "equivalency" approach. The basic hypothesis of AEM is that while equivalencies can be developed, the nature of the relationship changes with the distance between the aircraft and the observation point. This assumption can be illustrated by considering noise versus distance curves-- a basic input to models like INM-- for two hypothetical aircraft as shown in Figure 2.1.

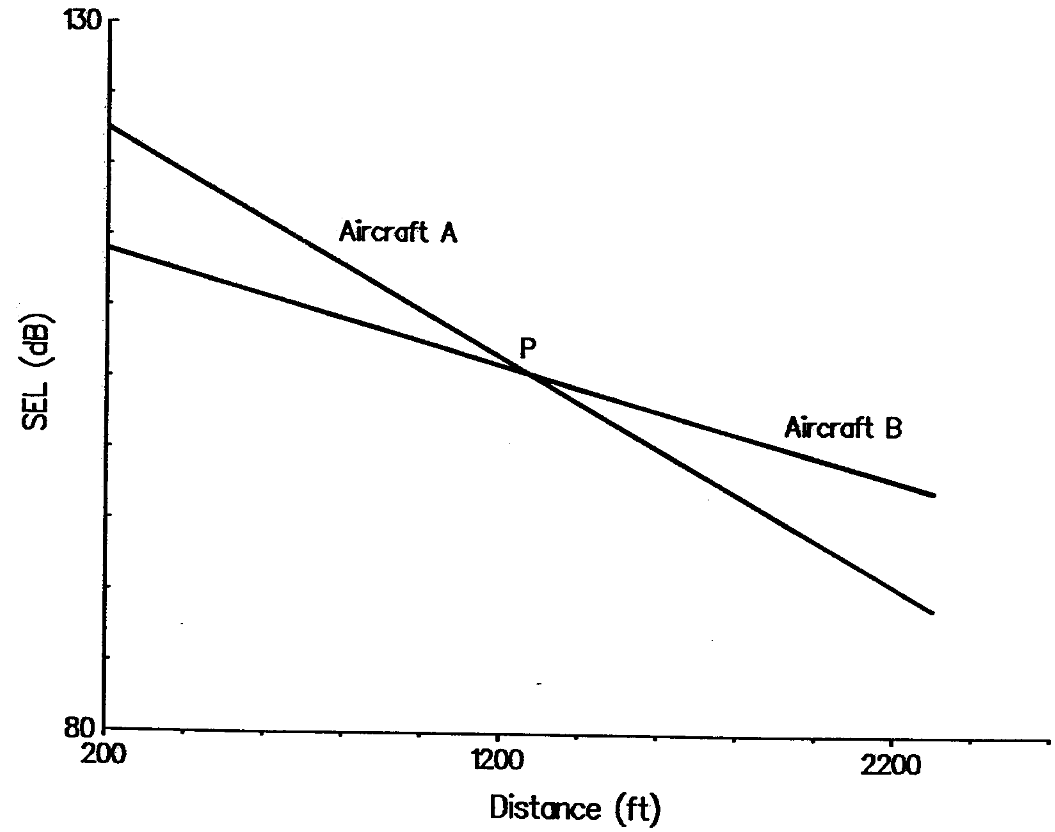

Figure 2.1 Noise Versus Distance

The curves for both aircraft A and B are at constant thrust level and noise for both decreases with distance. Note that at a distance from the aircraft of less than P, aircraft mix to estimate area and compared AEM estimates to available INM estimates for 30-NEF (65-LDN). AEM estimates were based on single-runway and two-runway airports with a standard runway utilization split.

area (in square miles) for a specific case of aircraft operations, given the mix of aircraft types and the number of landing-takeoff cycles (LTOs) per aircraft. In order to create the AEM, aircraft specific parameters relating DNL noise contour area to LTOs were derived from INM output for DNL 65dB. These parameters, represented by the variables *a* and *b*, are constants which produce the 65 L_{dn} contour area due to a specific number of operations of an aircraft from the following equation:

$$A = aN^b$$

Equation 3.1

The constant *a* is the noise contour area in square miles of a single LTO for an aircraft. The constant *b* is a scaling parameter which determines the change in contour area relative to a change in number of effective LTOs for an aircraft. The noise contour area A is the result of applying the parameters *a* and *b* to *N*, the number of effective LTOs. The number of effective LTOs is the sum of the daytime LTOs and the nighttime LTOs of an aircraft. The nighttime LTOs are weighted by a multiple of 10 due to account for the increase in annoyance to the community during the nighttime hours between 10pm and 7am.

3.2 Calculation of Parameters and Coefficients

The Integrated Noise Model(INM) Version 3.9 was used to produce aircraft noise contour areas for specific numbers of LTOs. INM was run for each of the 81 aircraft in the INM Version 3.9 data base. The parameters *a* and *b* were determined from the linear regression equation:

$$\log A = \log a + b \log N$$

Equation 3.2

The parameters *a* and *b* were calculated based on running the INM only once for each aircraft type, using 100 LTO cycles, and requesting contour areas for eight contour intervals. The eight contour intervals equate to DNL 65dB for 100 LTOs at different values of LTOs cycles. The result of this exercise was the area of the DNL 65dB contour as a function of LTO cycles at eight intervals over a range covering a 100-fold increase in LTO cycles.

```
SETUP:
TITLE <CALCULATING PARAMETERS A AND B>
AIRPORT <AIRCRAFT 727Q15>
ALTITUDE 0
TEMPERATURE 15 C
RUNWAYS
RW 09-27    0    0   TO 10000    0      HEADING=90
AIRCRAFT:
TYPES
AC 727Q15
INT.NM.
TAKEOFFS BY FREQUENCY:
TRACK TR1 RWY 09 STRAIGHT 50
OPER 727Q15 STAGE 4 D=100
LANDING BY FREQUENCY:
TRACK TR2 RWY 09 STRAIGHT 50
OPER 727Q15 PROF=STD3D D=100
PROCESSES:
FT.
CONTOUR LDN AT 55 58 62 65 68 72 75 85
 REFINE=7
 XSTART=-50000
 YSTART=-90000
 XSTOP=130000
 YSTOP=90000
PLOT
END.
```

Figure 3.1 INM Input File for 727Q15 AEM Parameters

Step 2. Run the INM version 3.9 to find corresponding contour areas for each aircraft type.

Step 3. Using Equation 3.2 and regression analysis, determine the parameters *a* and *b* and correlation coefficient r. For example, the AEM parameters for the 727Q15 were obtained in the following manner:

55	1000	55.02
58	500	34.41
62	200	17.09
65	100	10.99
68	50	7.06
72	20	4.50
75	10	2.72
85	1	0.47

Next, the logarithm base 10 of N and A resulted in:

Log N	**Log A**
3.0	1.74052
2.69897	1.53668
2.30102	1.232742
2.0	1.040997
1.69897	0.880813
1.30102	0.6532125
1.0	0.4345689
0.0	-0.327902

Finally, using regression analysis, the parameters a and b and the correlation coefficient r were produced for the 727Q15:

$a = 0.525620$, $b = 0.673303$, and $r = 0.997$

Figure 3.2 illustrates the linear regression line derived from Equation 3.1 for DNL 65dB. The INM produced the contour areas as shown by the symbol (♦). The graph is based on a relationship between the contour area in square miles and the number of LTOs of an aircraft at DNL 65dB. Below the regression line is the equation of that line and the value for the correlation coefficient. The correlation coefficient, r, indicates how well the regression line represents the relationship of

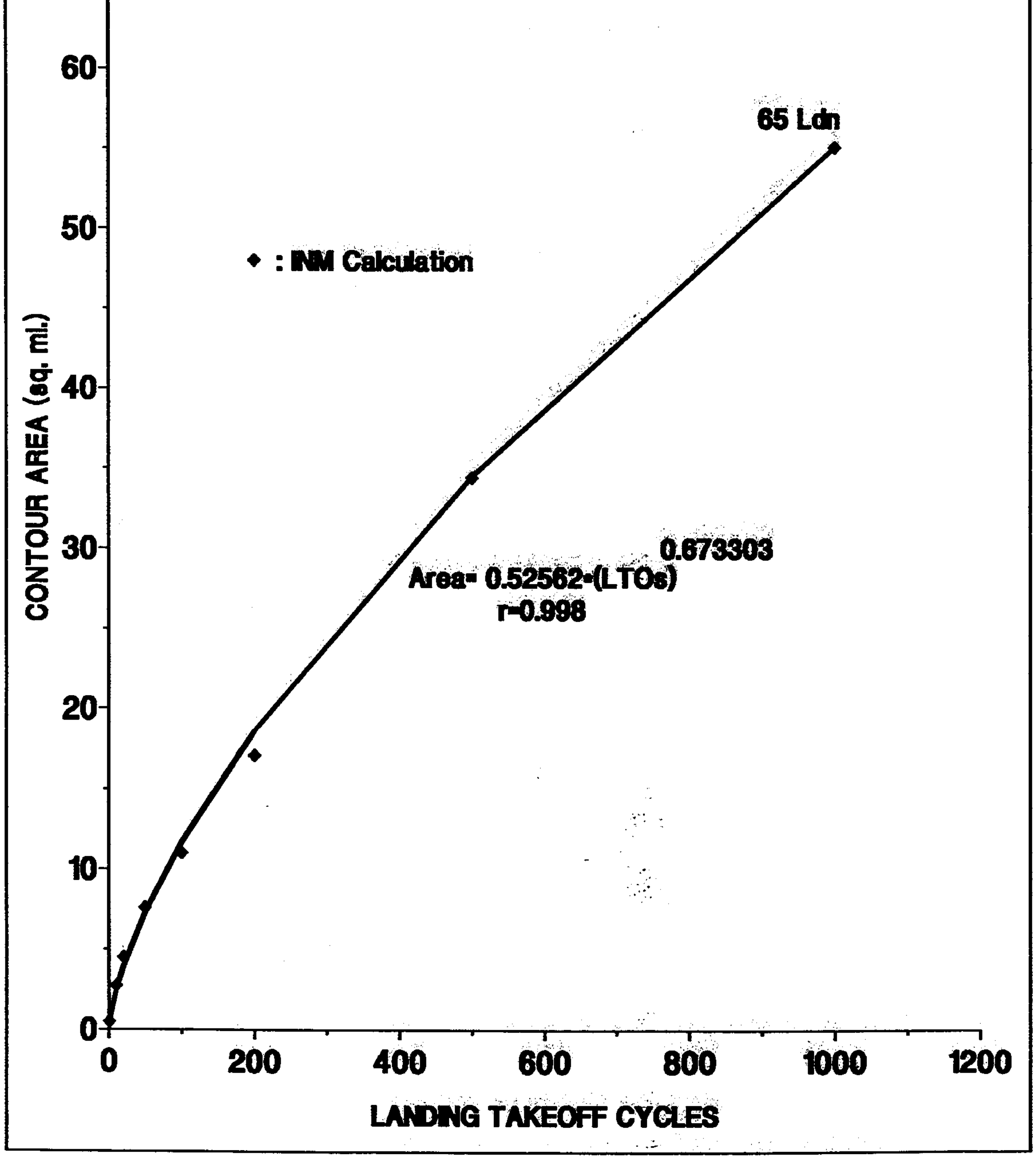

Figure 3.2 Example of AEM Linear Regression Equation

Aircraft Type	Constants a	b	r	Aircraft Type	Constants a	b	r
747100	0.304285	0.658576	0.996	DC910	0.133105	0.703529	0.997
747200	0.177293	0.62158	0.981	737	0.170635	0.726786	0.999
74710Q	0.15925	0.617	0.982	DC9Q9	0.165318	0.687523	0.999
747SP	0.110422	0.644643	0.985	DC9Q7	0.109113	0.701627	0.995
74720B	0.205337	0.673759	0.997	737QN	0.150364	0.719306	0.997
DC820	0.359337	0.63648	0.999	DC950	0.376077	0.673586	0.997
707	0.294652	0.633867	0.999	737D17	0.316961	0.688566	0.996
720	0.207455	0.654429	0.999	MD81	0.073914	0.58979	0.976
707320	0.412187	0.667443	0.999	MD82	0.090546	0.594836	0.975
707120	0.352951	0.656814	0.999	MD83	0.104014	0.595121	0.977
720B	0.308278	0.66335	0.999	757RR	0.066498	0.467502	0.958
DC850	0.42626	0.63595	0.999	757PW	0.066774	0.463116	0.957
DC860	0.460282	0.661887	0.999	COMJET	0.185237	0.61644	0.998
DC870	0.08773	0.57640	0.967	LEAR35	0.076593	0.499148	0.980
BAE146	0.055158	0.489306	0.965	LEAR25	0.302217	0.646608	0.999
707QN	0.281817	0.733202	0.999	SABR80	0.076821	0.541982	0.975
DC8QN	0.307992	0.731086	0.999	CNA500	0.02879	0.456367	0.967
CONCRD	3.924388	0.60921	0.968	CL600	0.076136	0.419528	0.971
DC1010	0.116343	0.598848	0.976	GIIB	0.332442	0.676289	0.999
DC1030	0.115737	0.600002	0.981	MU3001	0.051992	0.547802	0.976
DC1040	0.111153	0.607887	0.984	CL601	0.068281	0.361529	0.978
L1011	0.121141	0.604519	0.976	IA1125	0.076317	0.524831	0.983
L10115	0.131421	0.603588	0.975	L188	0.044374	0.587324	0.956
727200	0.319045	0.708298	0.999	DHC8	0.019764	0.483229	0.989
727100	0.242546	0.727589	0.999	DHC7	0.009595	0.535912	0.984
727D15	0.563996	0.680164	0.999	CVR580	0.049529	0.465339	0.958
727Q9	0.343154	0.689011	0.999	HS748A	0.047822	0.585972	0.968
727Q7	0.209488	0.724006	0.998	SD330	0.030536	0.451521	0.965
727Q15	0.52562	0.673303	0.998	DHC6	0.013054	0.651903	0.968
727D17	0.573033	0.675911	0.997	DC6	0.115556	0.672129	0.981
A300	0.101093	0.549823	0.965	DC3	0.090119	0.610581	0.973
767CF6	0.06995	0.567831	0.966	SF340	0.023303	0.501792	0.978
767JT9	0.067898	0.575279	0.963	CNA441	0.009838	0.461518	0.993
A310	0.082781	0.560335	0.966	GASEPV	0.006502	0.692301	0.981
737300	0.047459	0.531217	0.954	GASEPF	0.00604	0.493824	0.987
7373B2	0.045398	0.554531	0.957	BEC58P	0.012504	0.643938	0.972
BAC111	0.103825	0.634485	0.984	COMSEP	0.001393	0.820867	0.991
F28MK2	0.136659	0.724956	0.995	KC135	2.649494	0.591283	0.990
F28MK4	0.104984	0.676059	0.990	F4C	1.17629	0.599203	0.998
DC930	0.188063	0.695462	0.999	A7D	0.48011	0.641196	0.999
C130	0.069244	0.644966	0.974				

TABLE 3-1 AEM Parameters and Correlation Coefficients

The following descriptions should show you how AEM Version 2 works:

Column 1: Aircraft number. This column shows you how many of aircraft entered.

Column 2: Type of aircraft (see Appendix A).

Column 3: Number of daytime landing-takeoff cycles (07:00 - 21:59 hours).

Column 4: Number of nighttime landing-takeoff cycles (22:00 - 06:59 hours).

Column 5: Weighted LTOs (N) which is sum of the daytime LTOs from column 3 and the nighttime from column 4 multiplied by 10 of each aircraft.

Column 6: The constant a, the noise contour area in square miles of a single LTO for an aircraft.

Column 7: The constant b, a scaling parameter which determines the change in contour area relative to a change in the number of effective LTOs for an aircraft.

Column 8: The noise contour area, $A = aN^b$, for each aircraft where a is in column 6, b is in column 7, and N is in column 5.

Column 9: Energy contribution, $E=(A/A_R)^{1/b}$, for each aircraft where A is area of each aircraft in column 8, A_R, reference area, is largest area in column 8 of aircraft mix, and b is in column 7. Maximum value of E is 1.0.

Column 10: Weighting factor, $W=E/b$, for each aircraft where E is in column 9 and b is in column 7.

Column 11: Verification number of LTOs of each aircraft, $\overline{N}=(\overline{A}/a)^{1/b}$, where $\overline{A}$ is contour area of aircraft mix and a is in column 6.

Column 12: Verification effective LTOs of each aircraft by applying the equation $N/\overline{N}$ where N is in column 5 and $\overline{N}$ is in column 11.

Total LTOs: 0 0

DNL 65dB

Contour Area: NA sq. mi. DNL 65dB

	Aircraft	LTO	Cycles		Constants			Aircraft		To Verify		Area
No	Type	Day	Night	Weighted	a	b	Area	Energy	Wgtings	LTOs	Eff	LTOs
1	0	0	0	0	NA	NA	0	0	0	0		0
2	0	0	0	0	NA	NA	0	0	0	0		0
3	0	0	0	0	NA	NA	0	0	0	0		0
4	0	0	0	0	NA	NA	0	0	0	0		0
5	0	0	0	0	NA	NA	0	0	0	0		0
6	0	0	0	0	NA	NA	0	0	0	0		0
7	0	0	0	0	NA	NA	0	0	0	0		0
8	0	0	0	0	NA	NA	0	0	0	0		0
9	0	0	0	0	NA	NA	0	0	0	0		0
10	0	0	0	0	NA	NA	0	0	0	0		0
11	0	0	0	0	NA	NA	0	0	0	0		0
12	0	0	0	0	NA	NA	0	0	0	0		0
13	0	0	0	0	NA	NA	0	0	0	0		0
14	0	0	0	0	NA	NA	0	0	0	0		0
15	0	0	0	0	NA	NA	0	0	0	0		0
16	0	0	0	0	NA	NA	0	0	0	0		0
17	0	0	0	0	NA	NA	0	0	0	0		0
18	0	0	0	0	NA	NA	0	0	0	0		0
19	0	0	0	0	NA	NA	0	0	0	0		0
20	0	0	0	0	NA	NA	0	0	0	0		0
21	0	0	0	0	NA	NA	0	0	0	0		0
22	0	0	0	0	NA	NA	0	0	0	0		0
23	0	0	0	0	NA	NA	0	0	0	0		0
24	0	0	0	0	NA	NA	0	0	0	0		0
25	0	0	0	0	NA	NA	0	0	0	0		0
26	0	0	0	0	NA	NA	0	0	0	0		0
27	0	0	0	0	NA	NA	0	0	0	0		0
28	0	0	0	0	NA	NA	0	0	0	0		0
29	0	0	0	0	NA	NA	0	0	0	0		0
30	0	0	0	0	NA	NA	0	0	0	0		0
31	0	0	0	0	NA	NA	0	0	0	0		0
32	0	0	0	0	NA	NA	0	0	0	0		0
33	0	0	0	0	NA	NA	0	0	0	0		0
34	0	0	0	0	NA	NA	0	0	0	0		0
35	0	0	0	0	NA	NA	0	0	0	0		0
							0	0	0			0
	Totals:	0	0	0			0<Ref. Area		Validity Test			0
									(1=TRUE, 0=FALSE)			

Contour Area = NA sq. mi.

Figure 3.3 DNLAEM, The AEM Version 2 Template

using BALER® software. Baling generates BASIC code which, in conjunction with other BALER programs, forms a machine language template which is similar to the original LOTUS 1-2-3 template, but is improved in several ways. BALER is a trademark of Brubaker & Associates, Inc.

The Area Equivalent Method (AEM) on VISICALC® was released in February 1984 by Thomas L. Connor and David N. Fortescue (Reference 3). This release required the VISICALC software package and an Apple® IIe personal computer. AEM on LOTUS 1-2-3 was released in July 1984 by Donna G. Warren (Reference 4). This release required LOTUS 1-2-3 and an IBM® or compatible personal computer. The newest release, Version 2 of the AEM, offers substantial improvements over AEM on VISICALC and LOTUS 1-2-3. Most importantly, it contains a more useful method of calculating the noise contour area without using the VISICALC or the LOTUS 1-2-3 software programs. This version also includes:

- The updated parameters a and b and the correlation coefficients for all 81 aircraft in the INM Data Base No. 9.
- An on-screen listing of aircraft types while entering data.
- A maximum of 35 inputs is now allowed.
- A NOVICE mode to run the AEM with the use of AEM menus and input screen without knowing LOTUS 1-2-3. Some knowledge of LOTUS 1-2-3 is helpful.
- An automatic ERROR check for misspelled aircraft type names.
- An automatic recalculation of Contour Area until the Validity test is equal to 1 (TRUE).

4.2 Requirements

AEM Version 2 does not require any programming experience. It does require an IBM® Personal Computer (or compatible), MS DOS® 2.1 (or higher), and at least 280 kilobytes (KB) of Random Access (RAM). The following is a list of the files contained on the AEM diskette which must be present in order to run AEM:

4.3 Installation

AEM may be run either from the floppy drive or from your hard disk. Once you have turned on your computer and have received the **C>** prompt, follow the instructions in Section 4.3.1 to run AEM from the hard drive or Section 4.3.2 to run from the floppy drive.

4.3.1 Hard Drive Installation

Step 1. If you are not in the root directory, change the directory by typing **cd c:**.

Step 2. Create an AEM subdirectory by typing **md \aem**. (See your DOS manual for more information on directories).

Step 3. Make the AEM directory the current directory by typing **cd \aem.**

Step 4. Insert the AEM diskette in drive A and close the door. Type **copy a:*.***.

Step 5. When DOS indicates that all files have been copied and the light on drive A is off, remove the AEM diskette from the drive and put it away. You are now ready to run AEM. Continue to Section 4.4.

4.3.2 Floppy Drive Installation

Step 1. Make a backup copy of your diskette using either the DISKCOPY (for a single floppy drive) or COPY (for dual floppy drives) DOS command. See your DOS manual for more information on these commands.

Step 2. Insert the AEM diskette in drive A and close the door. Type **a:** to get the A> prompt. You are now ready to run AEM. Continue to Section 4.4.

(Figure 4.1).

NOVICE EXPERT EXIT
Run AEM with the use of AEM menus and input screens

DNLAEM
Version 2.0

DAY NIGHT AVERAGE SOUND LEVEL
AREA EQUIVALENT METHOD

Federal Aviation Administration
Office of Environment and Energy
Washington, D.C. 20591

Figure 4.1 The Introduction Screen

Step 2. Select either NOVICE or EXPERT mode to run AEM. If you select NOVICE mode, go to Section 4.4.1 . If you select EXPERT mode, go to Section 4.4.2 .

4.4.1 Novice Mode:

This option allows you to run AEM with the use of AEM menus and input screens. There are eight menu items displayed on the screen (Figure 4.2). Each menu item will perform a different task, including:

- Enter the title, aircraft type, and number of landing-takeoff cycles (see Sections 5.1 and 5.2).
- Calculate the area of the 65 DNL contour (see Section 5.3).

TITLE DATA CALCULATE SAVE GET PRINT NEW QUIT
Enter a title

DNLAEM
Version 2.0

DAY NIGHT AVERAGE SOUND LEVEL
AREA EQUIVALENT METHOD

Federal Aviation Administration
Office of Environment and Energy
Washington, D.C. 20591

Figure 4.2 The Novice Mode Screen

4.4.2 Expert Mode:

Upon choosing this option, Figures 4.3 and 4.4 will be displayed to run AEM at the BALER command level follow these steps:

- Go to cell I6 to enter the TITLE.
- Go to cell I16 to begin entering aircraft type and number of landing-takeoff cycles (LTOs).
- Press **<ALT>C** to calculate your current worksheet.
- Press **<ALT>P** to print your current worksheet.
- Press **<ALT>S** to save your current worksheet.

While in the EXPERT mode, press ALT and C to recalculate.

Re-enter NOVICE mode at anytime by pressing ALT and N

or

restart AEM from beginning at anytime by pressing ALT and A.

Figure 4.3 The Expert Mode Screen

DNLAEM
Version 2.0
Day Night Average Sound Level
Area Equivalent Method

TESTCASE <<<Title

		Day	Night				
Total LTOs:		0	0				
DNL 65dB							
Contour area:		NA sq. mi.			DNL 65dB		
	Aircraft	LTO Cycles			Constants		Aircraft
No.	Type	Day	Night	Weighted	a	b	Area
1.	0	0	0	0	NA	NA	0
2.	0	0	0	0	NA	NA	0
3.	0	0	0	0	NA	NA	0
4.	0	0	0	0	NA	NA	0
5.	0	0	0	0	NA	NA	0

Figure 4.4 Entering Expert Mode

TITLE DATA CALCULATE SAVE GET PRINT NEW QUIT

5.1 Title

Enter description of airport scenario (see Figure 5.1). You may change by pressing menu item **Title.** It will accept up to twenty characters.

Enter title (Maximum of 20 characters). Press ' to start entering.
Press <ENTER> when done.

TESTCASE <<<TITLE

Figure 5.1 The Title Screen

5.2 Data

Begin entry of aircraft type and number of landing-takeoff cycles (LTOs) in the appropriate columns. To view aircraft type descriptions, press **F6** key to switch to right window and use up and down arrow keys to scroll through this window (see Figure 5.2).

				65	aircraft types and number of		
		Day	Night	66	operations into left window. Press		
Total LTOs:		0	0	67	<ENTER>when done.		
				68	====================		
DNL 65dB				69	Aircraft	Aircraft	Aircraft
Contour area:		NA	sq. mi.	70	Type	Description	ID
				71			
	Aircraft	LTO Cycles		72	747100	B747-100/JT9BD	1
No.	Type	Day	Night	73	747200	B747/200/JT9DFL	2
1.	0	0	0	74	74710Q	B747-100QN/JT9DFL	3
2.	0	0	0	75	747SP	B747SP/JT9DFL	4
3.	0	0	0	76	74720B	B747-200B/JT9D-7Q	5
4.	0	0	0	77	DC820	DC-8-20/JT4A	6
5.	0	0	0	78	707	B707-120/JT3C	7

Figure 5.2 The Data Screen

5.3 Calculate

Calculate the area of the DNL 65dB contour. AEM will warn you with the message ERROR IN CALCULATION if aircraft type name is misspelled. In this case you must press <ALT>N to return to NOVICE mode and then check and correct misspelled aircraft type(s) (see Figure 5.3).

5.4 Save

Save the current worksheet. The format is *filename.ext.* If you enter only *filename*, the extention *.wk1* will be added (see Figure 5.4).

5.5 Get

List filenames of previously saved worksheets so that you can retrieve desired file (see Figure 5.5).

Area Equivalent Method			60	Reference Area	0
			61		
TESTCASE	<<<Title		62	Validity Test	0
			63	(1=TRUE,0=FALSE)	
	Day	Night	64		
Total LTOs:	0	0	65	Contour Area:	NA sq. mi.
			66		
DNL 65dB			67	==================	
Contour area:	NA sq. mi.		68		
			69	If Validity test is equal to 0 (FALSE),	
Aircraft	LTO Cycles		70	AEM worksheet will automatically enter	
No. Type	Day	Night	71	a new reference contour area and recal-	
1. A300	5	1	72	culate contour area until the Validity	
2. DC8QN	7	2	73	test is equal to 1 (TRUE).	
3. 0	0	0	74		
4. 0	0	0	75		
5. 0	0	0	76		

Figure 5.3 The Calculate Screen

Enter file name to save:							
H	I	J	K	L	M	N	O
Directory of files *.wk1							
BAEM.WK1							

Figure 5.4 The Save Screen

Figure 5.5 The Get Screen

5.6 Print

Print the current worksheet (see Figure 5.6). AEM includes the print setup string, **\015** which invokes condensed print mode for EPSON printers. If you are not using a wide carriage printer with 14 7/8"x11" paper, a printer setup string must be entered to compress the characters output. The setup string will usually be in the form \xxx. The setup string is determined by the printer type. Consult the printer manual for the correct setup string. In order to replace **\015** you press <ESC> and then type xxx. Figure 5.7 shows a complete worksheet printed in condensed mode.

5.7 New

Replace the current data. AEM will query you to confirm this action with a YES or NO.

5.8 Quit

Return to main menu. This menu item is equivalent to <ESC> key (see Figure 4.3). You can quit AEM by selecting **Exit** from the main menu.

Area Equivalent Method

TESTCASE <<<Title

	Day	Night
Total LTOs:	12	3

DNL 65dB
Contour area: 3.49 sq. mi.

No.	Aircraft Type	LTO Cycles Day	Night	Weighted	DNL 65dB Constants a	b	Aircraft Area
1.	A300	5	1	15	0.101093	0.549823	0.448087
2.	DC8QN	7	2	27	0.307992	0.731086	3.427594
3.	0	0	0	0	NA	NA	0
4.	0	0	0	0	NA	NA	0
5.	0	0	0	0	NA	NA	0

Figure 5.6 The Print Screen

DNL 65dB

Contour Area: 6.96 sq. mi.

DNL 65dB

No	Aircraft Type	LTO Day	Cycles Night	Weighted	Constants a	b	Area	Aircraft Energy	Wgtings	To Verify LTOs Eff	Area LTOs
1	A300	100	1	20	0.101093	0.549823	0.[illegible]24876	0.014143	0.025724	2198.724	0.009096
2	DC8QN	21	3	51	0.307992	0.731086	5.[illegible]56574	1	1.367828	71.07941	0.717507
3	747200	11	2	31	0.177293	0.62158	1.[illegible]986[illegible]2	0.125053	0.201185	366.3028	0.084629
4	DC9Q9	22.5	2.1	43.5	0.165318	0.687523	2.2121[illegible]3	0.268961	0.391203	230.2012	0.188965
5	0	0	0	0	NA	NA	0	0	0	0	0
6	0	0	0	0	NA	NA	0	0	0	0	0
7	0	0	0	0	NA	NA	0	0	0	0	0
8	0	0	0	0	NA	NA	0	0	0	0	0
9	0	0	0	0	NA	NA	0	0	0	0	0
10	0	0	0	0	NA	NA	0	0	0	0	0
11	0	0	0	0	NA	NA	0	0	0	0	0
12	0	0	0	0	NA	NA	0	0	0	0	0
13	0	0	0	0	NA	NA	0	0	0	0	0
14	0	0	0	0	NA	NA	0	0	0	0	0
15	0	0	0	0	NA	NA	0	0	0	0	0
16	0	0	0	0	NA	NA	0	0	0	0	0
17	0	0	0	0	NA	NA	0	0	0	0	0
18	0	0	0	0	NA	NA	0	0	0	0	0
19	0	0	0	0	NA	NA	0	0	0	0	0
20	0	0	0	0	NA	NA	0	0	0	0	0
21	0	0	0	0	NA	NA	0	0	0	0	0
22	0	0	0	0	NA	NA	0	0	0	0	0
23	0	0	0	0	NA	NA	0	0	0	0	0
24	0	0	0	0	NA	NA	0	0	0	0	0
25	0	0	0	0	NA	NA	0	0	0	0	0
26	0	0	0	0	NA	NA	0	0	0	0	0
27	0	0	0	0	NA	NA	0	0	0	0	0
28	0	0	0	0	NA	NA	0	0	0	0	0
29	0	0	0	0	NA	NA	0	0	0	0	0
30	0	0	0	0	NA	NA	0	0	0	0	0
31	0	0	0	0	NA	NA	0	0	0	0	0
32	0	0	0	0	NA	NA	0	0	0	0	0
33	0	0	0	0	NA	NA	0	0	0	0	0
34	0	0	0	0	NA	NA	0	0	0	0	0
35	0	0	0	0	NA	NA	0	0	0	0	0
							5.456574	1.408158	1.985942		1.000197
	Totals:	64.5	8.1	145.5							

5.456574<Ref. Area   Validity Test   1

(1=TRUE, 0=FALSE)

Contour Area = 6.96 sq. mi.

Figure 5.7 Example of AEM Output

Version 2 software.

6.1 Instructions

Step 1. Enter aircraft types in column 1 of Figure 6.1.

Step 2. Enter the daytime and nighttime LTOs for each aircraft type in columns 2 and 3, respectively.

Step 3. Compute the effective LTOs of each aircraft in column 4 by multiplying the nighttime LTOs from column 3 by 10 and adding the daytime LTOs from column 2.

Step 4. Enter in columns 5 and 6 the appropriate aircraft a and b parameters for 65 Ldn from Table A-1.

Step 5. Compute the area of each aircraft by applying the equation, $A = aN^b$, where a is in column 5, b is in column 6, and N is the number of effective LTOs in column 4. Enter the area A, for each aircraft in column 7.

Step 6. Select the largest area in column 7 and refer to this as the "reference area," A_R.

Step 7. Calculate the energy contribution E for each aircraft by applying the equation $E=(A/A_R)^{1/b}$, where A is the area of each aircraft in column 7, A_R is the reference area, and b is in column 6. Enter the result in column 8.

Step 8. Sum column 8 and enter the result in the box labeled $\overline{E}$.

Step 9. Calculate the weighting factor W for each aircraft with the equation $W=E/b$, where E is the energy contribution in column 8 and b is in column 6. Enter the quotient in column 9.

Step 10. Sum column 9 and enter the result in the box labeled $\overline{W}$.

Step 13. Determine the number of LTOs that each aircraft must fly in order to have a noise contour area equal to that of the entire mix by applying the equation $\overline{N}=(\overline{A}/a)^{1/b}$, where $\overline{A}$ is the DNL noise contour area of the entire mix, a is in column 5, and b is in column 6. Enter the result $\overline{N}$ in column 10.

Step 14. Calculate the ratio of LTOs of each aircraft by dividing the effective LTOs (N) in column 4 by $\overline{N}$ in column 10. Enter the result in column 11.

Step 15. Sum column 11 and enter the result in the box labeled 'Validity Check'.

Step 16. If the validity value is between 1.00 and 1.02 then the result is correct. You are done. Record the contour area from the box labeled "$\overline{A}$:" into the box labeled "Contour Area:".

Step 17. If the validity value is not between 1.00 and 1.02, return to Step 1 and check all your figures.

Step 18. If the validity check produces the same value, change the reference area according to the following:

- If the validity value is greater than 1.02, enter a reference area less than already present.

- If the validity value is less than 1.00, enter a reference area greater than already present.

Step 19. Repeat the steps starting at Step 7.

Day Night Average Sound Level
Area Equivalent Method
Calculator Method

Aircraft Type (1)	Daytime LTOs (2)	Nighttime LTOs (3)	Effective LTOs N (4)	Constants a (5)	b (6)	Aircraft Area $A=aN^b$ (7)	Energy $E=(A/A_R)^{1/b}$ (8)	Weighting Factor $W=E/b$ (9)	# of $\overline{N}$=(
						Reference A_R	Energy $\overline{E}$	Weighting $\overline{W}$	Va
						$\overline{b}$:	$\overline{A}$:	Contour Area:	

FIGURE 6-1 AEM CACULATOR METHOD WORKSHEET

Type	Description	ID	a	b
747100	B747-100/JT9BD	1	0.304285	0.658576
747200	B747/200/JT9DFL	2	0.177293	0.62158
74710Q	B747-100QN/JT9DFL	3	0.15925	0.617
747SP	B747SP/JT9DFL	4	0.110422	0.644643
74720B	B747-200B/JT9D-7Q	5	0.205337	0.673759
DC820	DC-8-20/JT4A	6	0.359337	0.63648
707	B707-120/JT3C	7	0.294652	0.633867
720	B720/JT3C	8	0.207455	0.654429
707320	B707-320B/JT3D-7	9	0.412187	0.667443
707120	B707-120B/JT3D-3	10	0.352951	0.656814
720B	B720B/JT3D-3	11	0.308278	0.66335
DC850	DC-8-50/JT3D-3	12	0.42626	0.63595
DC860	DC-8-60/JT3D-7	13	0.460282	0.661887
DC870	DC-8-70/CFM-56-2	14	0.08773	0.5764
BAE146	BAE 146/ALF 502R-5	15	0.055158	0.489306
707QN	B707-320B/JT3D-7QN	16	0.281817	0.733202
DC8QN	DC-8-60/JT3D-7QN	17	0.307992	0.731086
CONCRD	CONCORDE/OLY593	18	3.924388	0.60921
DC1010	DC-10-10/CF6-6D	19	0.116343	0.598848
DC1030	DC-10-30/CF6-50C2	20	0.115737	0.600002
DC1040	DC-10-40/JT9D-20	21	0.111153	0.607887
L1011	L-1011/RB211-22B	22	0.121141	0.604519
L10115	L-1011-500/RB211-524	23	0.131421	0.603588
727200	B727-200/JT8D-7	24	0.319045	0.708298
727100	B727-100/JT8D-7	25	0.242546	0.727589
727D15	B727-200/JT8D-15	26	0.563996	0.680164
727Q9	B727-200/JT8D-9QN	27	0.343154	0.689011
727Q7	B727-100/JT8D-7QN	28	0.209488	0.724006
727Q15	B727-200/JT8D-15QN	29	0.52562	0.673303
727D17	B727-200/JT8D-17	30	0.573033	0.675911
A300	A300/CF6-50C	31	0.101093	0.549823
767CF6	B767-200/CF6-80A	32	0.06995	0.567831
767JT9	B767-200/JT9D-7	33	0.067898	0.575279
A310	A310/CF6-80A	34	0.082781	0.560335
737300	B737-300/CFM56-3-B1	35	0.047459	0.531217
7373B2	B737-300/CFM56-3B-2	36	0.045398	0.554531
BAC111	BAC111/SPEY 512	37	0.103825	0.634485
F28MK2	F28 MK2000/RB.183-2	38	0.136659	0.724956
F28MK4	F28 MK4000/RB.183-2P	39	0.104984	0.676059
DC930	DC-9-30/JT8D-9	40	0.188063	0.695462

DC9Q9	DC-930/JT8D-9QN	43	0.165318	0.687523
DC9Q7	DC-9-10/JT8D-7QN	44	0.109113	0.701627
737QN	B737/JT8D-9QN	45	0.150364	0.719306
DC950	DC-9-50/JT8D-17	46	0.376077	0.673586
737D17	B737/JT8D-17	47	0.316961	0.688566
MD81	MD-81/JT8D-209	48	0.073914	0.58979
MD82	MD-82/JT8D-217A	49	0.090546	0.594836
MD83	MD-83/JT8D-219	50	0.104014	0.595121
757RR	B757/RR 535E	51	0.066498	0.467502
757PW	B757/PW2037	52	0.066774	0.463116
COMJET	COMPOSITE GA JET	53	0.185237	0.61644
LEAR35	GATES LEAR 35/TFE731	54	0.076593	0.499148
LEAR25	GATES LEAR 25/CJ610	55	0.302217	0.646608
SABR80	N.A. SABRELINER 80	56	0.076821	0.541982
CNA500	CESSNA CITATION I	57	0.02879	0.456367
CL600	CHALLENGER CL-601	58	0.076136	0.419528
GIIB	GULFSTREAM GIIB/SPEY	59	0.332442	0.676289
MU3001	MITSUBISHI DIAMOND I	60	0.051992	0.547802
CL601	CHALLENGER CL-601	61	0.068281	0.361529
IA1125	IAI 1125 ASTRA	62	0.076317	0.524831
L188	LOCKHEED 188 ELECTRA	63	0.044374	0.587324
DHC8	DHC-8/PW120	64	0.019764	0.483229
DHC7	DHC-7/PT6A-50	65	0.009595	0.535912
CVR580	CONVAIR 580	66	0.049529	0.465339
HS748A	BAE HS 748A/DART	67	0.047822	0.585972
SD330	SHORTS SD3-30	68	0.030536	0.451521
DHC6	DHC-6/PT6A-27	69	0.013054	0.651903
DC6	DC-6/R2800	70	0.115556	0.672129
DC3	DC-3/R2800	71	0.090119	0.610581
SF340	SAAB 340/CT7-5	72	0.023303	0.501792
CNA441	CESSNA CONQUEST II	73	0.009838	0.461518
GASEPV	GA SGL ENG VAR PITCH	74	0.006502	0.692301
GASEPF	GA SGL ENG FIX PITCH	75	0.00604	0.493824
BEC58P	BEECH BARON 58P	76	0.012504	0.643938
COMSEP	COMP. GA SINGLE ENG.	77	0.001393	0.820867
KC135	KC-135A/J57	78	2.649494	0.591283
F4C	F-4C,D,E,F/J79	79	1.176299	0.599203
A7D	A7D/TF41	80	0.48011	0.641196
C130	HERCULES/T56	81	0.069244	0.644966

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2. Flythe, M. C., "INM Integrated Noise Model, Version 3 User's Guide," FAA-EE-81-17, October 1982.

3. Connor, T. L. and Fortescue, D. N., "Area Equivalent Method on VISICALC ,"FAA-EE-84-8, February 1984.

4. Warren, D. G., "Area Equivalent Method on LOTUS 1-2-3 ,"FAA-EE- 84-12, July 1984.